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NEW TECHNIQUES, INCLUDING REMOTE SENSING, FOR IDENTIFYING, EXPLORING FOR AND ASSESSING MINERAL AND WATER RESOURCES

Report of the Secretary-General

SUMMARY

The present report provides information on the features of remote-sensing systems available through commercial outlets. It includes recent price schedules. It also summarizes the activities of the Department of Economic and Social Development with regard to remote sensing. In order to intensify its efforts to disseminate remote-sensing data, the Department has provided technical assistance to developing countries through seminars and workshops.

* E/C.7/1993/1.

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INTRODUCTION

1. At its second regular session in 1991, the Economic and Social Council took note of the report of the Secretary-General on information referral systems on satellite remote-sensing data (E/C.7/1991/7) and, in its resolution 1991/89, recommended that the Department of Technical Cooperation for Development of the Secretariat compile for dissemination to developing countries information on new data sets and the conditions under which such data can be obtained and the modalities for so doing. It also requested that the Secretary-General intensify his efforts to strengthen the capability of the developing countries in the application of remote-sensing techniques for the identification and subsequent exploration, exploitation and development of natural resources through workshops, seminars and training courses, to be organized at the regional or country level in developing countries. The Secretary-General was also requested to submit to the Committee on Natural Resources at its thirteenth session a report on the implementation of the resolution.

2. In response to those requests, the present report summarizes the appropriate action taken within available resources to implement resolution 1991/89.

3. Satellite remote sensing is a highly advanced technology which is being integrated into resources exploration programmes and environmental monitoring. In view of present and past developments in space, new data sets which lead to new products and services can be expected in the decades to come. The access to such real-time data processing is of particular importance to managers and decision makers concerned with environmental issues, disaster mitigation and other problems of global concern. The Department, over the years, has taken this technology into account in its projects, especially those for national resources development and environmental monitoring.

4. It has been pointed out that recent developments in user-friendly, low-cost image-processing hardware and software systems with high storage capacity, and the growth of geographic information systems (GIS), have expanded the capabilities and applications of remote-sensing computer systems for image-processing and image analysis. The operational use of these systems in developing countries is increasing and will contribute to meeting information needs.

5. Under agreements signed with the Earth Observation Satellite Company (EOSAT), an international Landsat data distribution network has been established to provide access to data under commercial agreements. Many developing countries have made a heavy capital investment in developing their own ground facilities. However, they now face a problem: continued data access is not guaranteed, either because of a cutback in the programme of the country providing the satellite services or because of a malfunction of the satellite with no prospect of an immediate replacement.

I. NEW DATA SETS

6. In the 1989 report of the Secretary-General on remote sensing (E/C.7/1989/2), it was suggested that, in view of the continuing financial constraints of the Organization, the Secretary-General should use, to the greatest extent possible, existing databanks and referral systems as a basis for assisting interested Member States. Current information on access to remote-sensing systems through commercial outlets is provided below. It updates information given in document E/C.7/1991/7. Owing to the rapid development of technology and the many services offered through private industry, only the major and primary outlets of satellite remote-sensing data will be covered. Mention of firm names and commercial products does not imply the endorsement of the United Nations.

7. The major tendency with respect to the final product of satellite information is to generate geocoded products - that is, precision-processed, map-projected satellite images that are free from distortions related to the sensor, the satellite, or the earth. Geocoded, Landsat, SPOT and other satellite data are precisely aligned to the reference system of an existing spatial database or serve as a reliable foundation for a new one. All corrections, including the elimination of terrain relief distortion, are applied to the imagery simultaneously.

8. Geocoded products provide image analysts, GIS and map users with a highly accurate and original cartographic data source for most areas of the world. Compatibility with an existing GIS or image-processing database or reference system is ensured, because each geocoded product is customized according to the client's requirements. Those may include map projection, reference earth ellipsoid, output pixel size, framing window and resampling method.

9. Satellite imagery can be grouped according to its spatial, spectral or temporal resolution, which determines the utility of the data for any given development or application in natural resource development. For instance, panchromatic SPOT imagery can offer a ground resolution of about 10 metres and multispectral SPOT imagery, 20 metres. Landsat TM imagery has a ground resolution of 30 metres.

10. The range of visible and near infra-red spectral bands sensed by satellite scanners offers earch science applications a wealth of band combinations with which to investigate the characteristic signatures or reflected/emitted electromagnetic energy returns of surface materials and vegetation.

11. With the exception of meteorological satellites, all earth resources satellites are polar-orbiting, passing over the same terrain at intervals of between 1 to 18 days. If cloud cover is minimal, it is possible to monitor environmental change by ordering subsequent scenes of a chosen area. Satellite data have been used in all resources areas and conditions related to the environment (see table 1).

Table 1. Applications of Landsat TM data

Agriculture, forestry and range resources	Land use and mapping	Geology	Water resources	Coastal resources	Environment
Discrimination of vegetation, crop, and timber types, range vegetation	Classification of land uses	Mapping of major geologic units	Determination of water boundaries and surface water areas	Determination of turbidity patterns and circulation	Monitoring surface mining and reclamation
Measure crop acreage	Cartographic mapping and map updating	Revising geologic maps	Mapping of floods and flood plains	Mapping shoreline changes	Mapping and monitoring of water pollution
Estimating crop yields	Categorization of land capability	Recognition of certain rock types	Determination of areal extent of snow and ice	Mapping of shoals and shallow areas	Determination of effects of natural disasters
Measure timber acreage	Monitoring urban growth	Delineation of unconsolidated rocks and soils	Measurement of glacial features	Mapping of ice for shipping	Monitoring environmental effects of man's activities
Forest harvest monitoring	Regional planning	Mapping igneous intrusions	Measurement of sediment and turbidity patterns	Tracing beach erosion	Assessing drought impact
Determination of range readiness and biomass	Mapping of transportation networks	Mapping recent volcanic surface deposits	Delineation of irrigated fields	Tracing oil spills and pollutants	Siting for solid waste disposal
Determination of vegetation vigor	Mapping of land/water boundaries	Mapping landforms	Inventory of lakes and wetlands	Bathymetry	Siting for power plants and other industries
Determination of vegetation stress	Flood plain management	Search for surface guides to mineralization	Estimating snow melt runoff		
Determination of soil conditions	Siting for transportation and transmission routes	Determination of regional structures			
Determination of soil associations		Mapping linears			
Assessment of grass and forest fire damage					
Wildlife habitat assessment					

Note: TM = thematic mapper.

A. EOSAT

12. In 1992 the Earth Observation Satellite Company (EOSAT) assumed its own operating costs, which relieved the United States Government of a $19 million subsidy. This was part of the effort to commercialize Landsat activities, which, under the Land Remote Sensing Act, will be funded privately after the launch of Landsat 6.

13. Landsat 6 is scheduled to be launched in 1993. It will maintain continuity with the data which have been collected since Landsat 1 was launched in 1972. In principle, Landsat 6 is similar to Landsat 3 and 4, but it includes several new features that will improve the data received from the Enhanced Thematic Mapper (ETM), with a 15-metre panchromatic-band co-registered with the seven multispectral bands and high- and low-gain settings for increased radio-metric resolution (table 2). New line products were made available by EOSAT in 1992.

14. The major change in the Thematic Mapper product line is the floating scene which provides images from any point along the Landsat path. The tape medium is also new. It makes digital imagery available on high-speed 8 mm tape cartridges.

15. Customers may order scene data for any 185-km by 170-km area along the same path. The price will be the same whether the scene is within or across Worldwide Reference System (WRS) row boundaries.

16. Digital sub-scenes (100 km by 100 km) and map sheets may also be taken from anywhere within a WRS path. The new 8 mm tape cartridge makes it possible to prepare a full scene on one tape, compared with as many as 12 tapes necessary in some current configurations.

17. Table 3 gives the prices as of October 1991.

Table 2. Band width specifications on the Landsat 6 ETM

Band number	Wavelength (μm)	Detectors	IFOV (μrad)	Ground resolution (metres)
PaN	0.50-0.90	SiPD (32)	18.5 x 21.3	13 x 15
1	0.45-0.52	SiPD (16)	42.5	30
2	0.52-0.60	SiPD (16)	42.5	30
3	0.63-0.69	SiPD (16)	42.5	30
4	0.76-0.90	SiPD (16)	42.5	30
5	1.55-1.75	InSB (16)	42.5	30
7	2.08-2.35	InSB (16)	42.5	30
6	10.4-12.5	HgCdTe (4)	170	120

Note: ETM = Enhanced Thematic Mapper.
IFOV = instantaneous field of view.

Table 3. EOSAT price sheet

Product	Price (United States $)
Thematic Mapper digital products	
Full scene	4 400
Quarter scene	3 100
Map sheet a/	2 500
Precision-corrected	1 100 extra
Terrain-corrected b/	450 extra
1,600 BPI format	10% extra
Duplicates	90/tape
Thematic Mapper photographic products	
Negative plus transparency c/	2 700
Print (each) d/	200
Multi-Spectral Scanner (MSS) products e/	
Digital full scene	1 000
Photographic color transparency	600
Color print (1:1 m)	1 000
Black/white transparency (1:1 m)	155

Source: Earth Observation Satellite Company, 4300 Forbes Boulevard, Lanham, Maryland 20706-9954.

Note: CCT = computer-compatible tape.
BPI = bytes per inch.

a/ Available on 8 mm cassette or CCT.

b/ Requires precision correction.

c/ Full scenes are path-oriented; quarter scenes and map sheets are map-oriented.

d/ Prints require negative and transparency.

e/ Less than two years old.

B. Russian satellite imagery

1. DD-5 digital imagery

18. Satellites produced by the Russian DD-5 system, were launched in spacecraft such as Cosmos 1546. Images were captured with a 6.000-element linear image sensor and processed with an 8-bit processor before being transmitted to Earth in 8-second bursts. The system's focal length was approximately 5 metres and the CCD array in the focal plane was about 8 cm long. 1/

19. The Government of the Russian Federation has declassified and made available to the public sector two-metre-resolution digital satellite imagery. The imagery originally had a higher resolution but for commercial purposes was degraded to two metres. The data were processed by digitizing a photographic product using a very large pixel kernel size. They are in a panchromatic mode and are presented on computer-compatible tapes with 8-bit data. Each scene contains approximately 40 megabytes of data, consists of 6,500 pixels by 6,500 lines and covers an area of 13^2 kilometres. Currently, the data is formatted to be read by computer-based image-processing systems.

20. Although the data have not been geo-referenced, there is no photographic distortion in them. The archival databank is very extensive, and almost all data are from 1989 or later. New acquisition data can be acquired and delivered to a customer within 45 days. Currently, data are available for all parts of the world except for those taken over Russian.

21. Prices are available upon request, and payment must be received before an order is processed. The distributor, Central Trading Systems, guarantees that the data will be delivered as ordered or the money will be refunded. 2/

2. KVR-1000 photographs

22. Two-metre photographs are the latest products to become available through Central Trading Systems from Russia. The high resolution is comparable to that of low-altitude aerial photography. The characteristics of KVR-1000 photography are listed below.

Frame format	180 x 180 mm
Scale (at a survey altitude of 200 km)	1:220,000
Longitudinal overlap	0%
Width of survey band (altitude of 200 km)	24 miles
Resolution	2 metres
Type of film used	Panchromatic, high density

23. Only photographic products - film negatives or positives, and prints in black and white - are available at this time. Enlargements of up to 25 times

are possible. Each image is accompanied by the photogrammetric and camera system data, allowing accurate rectification to maps and the removal of any lens distortion that may be present. Normal delivery time is 15-20 days. The price of film products, negative or positive, is $3,000; the price of a contact print is $1,000.

C. ALMAZ data

24. The ALMAZ-1 Synthetic Aperture Radar (SAR) provides the first commercially available satellite AR images of Earth. ALMAZ-1 SAR data complement or provide an alternative to those from other remote-sensing satellite systems. Some of the benefits are: weather independence, day- or night-time acquisitions that are independent of the Sun's illumination angle, identification of surface features, and potential differentiation of vegetation and surface material characteristics. By combining these benefits with the option to a user-specified range of the look angle, clients are able to acquire and use ALMAZ-1 SAR data that are optimized for applications as diverse as oil and gas exploration and oceanographic studies. ALMAZ-1 data are also used for forestry, urban planning, mapping and environmental monitoring.

25. The ALMAZ Corporation, a susidiary of the Space Commerce Corporation, was established to manage the world-wide marketing of imagery from the Soviet synthetic aperture radar satellite, ALMAZ.

26. The standard image covered is 40 X 40 kilometres. The price is $1,600 plus courier shipment and handling. An image covering 40 X 300 km can be produced.

27. Two levels of image are available: level A: digital recording of the initial image on magnetic tape combining parts of the initial image into the whole image; and level B: combining level-A processing with geometric/radiometric correction plus geographical referencing.

28. The initial radio-hologramme or processed data on photographs in the above formats has a resolution of about 20 m with six shades of gray.

29. The technical details are as follows:

Aperture probing pulse frequency	
Hologram	3 000 Hz
Synthesized image	1 500 Hz
Wavelength	9.6 cm
Polarization of emitted pulses	HH
Pulses discrete frequency	
Narrow band	28.8 MHz
Wide band	20.16 MHz

D. SPOT data items and options

30. Before ordering SPOT data items, each client is required to sign an agreement on general terms and conditions. This is done only once, and the agreement is kept on file at the SPOT Image Corporation. All orders are placed by completing a licence request form on which the client specifies the parametres under which the data items are to be produced (see annex). The order is filled under the terms stated in the agreement. Requests for SPOT catalogue searches, to determine whether the required data exist in the SPOT archive, are made through an inquiry form. If the required data do not exist in the archive, the client may complete the SPOT Acquisition Programming Request Form which allows the client to specify a set of imaging parametres under which imagery will be acquired to meet the client's needs.

31. Each SPOT scene is recorded in either the panchromatic (P) mode or multispectral (XS) mode (table 4). Panchromatic scenes have 10-metre ground resolution and a spectral resolution ranging from .51 µm to .73 µm. The number of pixels per line varies between 6,000 and 10,200, depending on the angle of incidence. The number of lines per scene varies between 6,000 and 10,200, depending on the level of processing applied to the imagery.

32. Multispectral images are composed of three spectral bands: XS1, XS2 and XS3, with spectral resolutions as shown in table 4. Each of the three bands has 20-metre ground resolution with 3,000-5,100 pixels per line, depending on the angle of incidence, and 3,000-5,100 lines per scene, depending on the processing level.

Table 4. Spectral and ground resolution of SPOT data

Spectral mode	Wavelength band (µm)	Resolution (metres)
Panchromatic	.51-.73	10
Multispectral		
XS1	.50-.59	20
XS2	.61-.68	20
XS3	.79-.89	20

33. In addition to SPOT data, the SPOT Image Corporation markets ALMAZ radar image products and Sojuzkarta data. The price schedule for all these products is given in table 5.

Table 5. SPOT product fee schedule*

1. Standard SPOT Products

		Panchromatic/Multispectral
Computer Compatible Tapes (CCT)	*Level 1A, 1B* (Full Scene) 6250 or 1600 bpi	$2,450
Film (30% discount w/corresponding CCT)	*Level 1A, 1B* 1:400,000 (Full Scene) 1:200,000 (Full Scene) 1:200,000 (1/4 Scene) 1:100,000 (1/4 Scene)	 $1,800 $1,800 $1,800 $1,800
Photographic Prints	When ordered alone When ordered with corresponding Level 1 CCT or film	$950 $300

2. SPOTView™ – GIS related products

	Digital	Photographic Print
7.5 – (corresponds to USGS 7.5 minute map series) P – Panchromatic XS – Multispectral	$950	$950 (1:24,000 7.5 XS not available)
15 – Four 7.5 minute SPOTViews creating 15 x 15 minute area P – Panchromatic XS – Multispectral	$2,000	$2,000 (1:50,000 or 1:63,360)
FS – Full SPOT scene (37 x 37 miles) P – Panchromatic XS – Multispectral	$3,000	$3,000 (1:100,000)

3. Other SPOT Products

	Digital	Photographic Film/Print
SPOT Digital Terrain Model (DTM) (60%-100% of full scene size/ minimum of 820 sq. mi.)	$15,000	
SPOT Quarter scene DTM	$10,000	
SPOT BasinView™ - complete coverage of any geologic basin in the world Panchromatic only	$1.25/sq. mi. minimum 2,500 sq. mi.	

* Effective August 1992.

II. EFFORTS TO STRENGTHEN THE CAPABILITIES OF DEVELOPING COUNTRIES

A. Interregional seminars

34. Recognizing the urgent needs of technology transfer to developing countries and in order to implement Economic and Social Council resolution 1991/89, the United Nations, in cooperation with the International Society for Photogrammetry and Remote-Sensing, convened an interregional seminar for developing countries in Washington, D.C., from 2 to 14 August 1992. Three sessions were devoted to issues relating to the viewpoints of manufacturers and users of remote-sensing technology, the educational needs of developing countries, the transfer process, and the integration and management of new technologies in recipient countries.

35. The first session focused on the need to accelerate the transfer of new mapping technologies and remote-sensing devices appropriate for capable end users. Experts examined the role of consultants, the importance of guidelines for State policies in the science and technology sector, training needs and the need to avoid "testing" new technology in developing countries, and ways in which new technologies could be integrated into a nation's economy, educational opportunities, infrastructure, living standards, habits and attitudes towards technologies.

36. The second session dealt with educational needs. Experts observed, among other things, that: the growth of modern mapping sciences in poorer countries had tended to rely on outsiders and were rarely controlled by indigenous scientists; developing countries needed to place more emphasis on applications and systems design; and there was a need for cooperation between specialists in different disciplines. Participants related experiences in Ethiopia, China and Jordan.

37. Speakers at the symposium included representatives from Argentina, Canada, China, Egypt, India, Indonesia, Kenya, Malawi, the Netherlands, Pakistan, Poland, Syrian Arab Republic, the United Kingdom and the United States.

B. Space Congress

38. The Department of Economic and Social Development also participated in the Space Congress which was held in Washington, D.C., from 25 August to 5 September 1992. More than 5,000 leading scientists attended, from developing as well as industrialized countries. The general theme was Discovery, Exploration and Cooperation. The event was co-sponsored by the United Nations, the International Astronautical Federation (IAF) and the Committee on Space Research (COSPAR). It was hosted and organized by the American Institute of Aeronautics and Astronautics (AIAA) and held under the auspices of the National Academy of Sciences and the National Aeronautics and Space Administration (NASA). The Congress was billed as the premier event for

International Space Year and provided a forum for many cooperative projects initiated by the Space Agency Forum for International Space Year (SAFISY).

39. Leading scientists and space policy makers took part in lectures and panel discussions. They reviewed the latest results and issues in the areas of space science, engineering, law and policy, which will influence space programmes into the next century.

40. In a session devoted to the importance of space technology for disaster reduction in developing countries, the Department presented a paper pointing out that technologies for humanitarian purposes had so far been underutilized. Natural disasters claimed hundreds of thousands of lives and caused billions of dollars worth of losses to housing and infrastructure in the developing world every year. Participants noted that much of that pain and loss could be avoided if populations in the world's poorest countries had adequate warning of impending threats, such as storms, floods, earthquakes, drought and insect infestations, which posed a constant threat to their survival.

C. Training courses

41. The Department of Economic and Social Development is preparing, with the office of Outer Space Affairs, a training programme on the use of microwave sensors in the Sahel region. The training course has the following objectives:

(a) To provide the understanding of remote-sensing techniques and specifically of remote-sensing applications to renewable resources and environment. That is: RS systems and available products, the field and laboratory work associated with RS techniques and the need and utilization of auxiliary external data;

(b) To provide detailed information on relevant projects on renewable resources management in the Sahel area;

(c) To provide an overview and practical utilization of image-processing tools and interpretation techniques;

(d) To expose the trainees to practical projects in application areas.

42. These projects respond to the critical economic and ecological situation of the Sahelian countries and to their wish to have more information and more knowledge on microwave sensors for the monitoring of renewable resources and the environment. Substantive matters, reaching the appropriate local policy makers, are expected to be treated in depth. The project is being carried out at the European Research Institute (ESRIN) of the European Space Agency (ESA, in Frascati, Italy) and will provide for the participation of Francophone technicians from the Sahel region. The training course is to be held from 19 to 30 April 1993.

43. Similar arrangements are being made for a training course in the use of microwave remote sensing for the countries in Latin America.

Notes

1/ Earth Observation Magazine (November 1992).

2/ For further information, contact Velon H. Minshew, Central Trading Systems, 611 Ryan Plaza Drive, Suite 700, Arlington, Texas 76011. Tel. (817) 459-0423; Fax (817) 459-0721.

Annex

License request cover sheet

SPOT Image Corporation
1897 Preston White Drive, Reston VA 22091-4368
(703) 620-2200 Telecopier (703) 648-1813

Licensee ID		Your P.O. Number	Number of License Requests Attached	Date
1 0 0 1 0 0				

Licensee Name	Authorized Signature
Contact Name/Data End User	☐ Check here if Joint Venture and refer to instruction 4.
Phone	Total Cost of Items Requested $
If an alternate shipping address is required please indicate in this space:	
	Surcharge for Rush Services $
	Virginia Residents ONLY add 4.5% State Tax $
	TOTAL $

Please Check SPOT Data Application

AGRICULTURE
- ☐ Domestic Inventory
- ☐ Foreign Inventory
- ☐ Yield Estimation
- ☐ Farm Management and Monitoring

GEOLOGY
- ☐ Lithologic Mapping
- ☐ Cadastral Mapping
- ☐ Structural Mapping
- ☐ Logistical/Environmental Planning

FORESTRY
- ☐ Inventory
- ☐ Deforestation Mapping
- ☐ Road Update Mapping
- ☐ Resource Planning

URBAN PLANNING
- ☐ Land Use Mapping
- ☐ Site Selection
- ☐ Regional Planning
- ☐ Industrial Development

DEFENSE
- ☐ Target Identification
- ☐ Terrain Analysis
- ☐ Surveillance
- ☐ Simulations

ENGINEERING & CONSTRUCTION
- ☐ Site Selection
- ☐ Environmental Impact Assessment
- ☐ Corridor Selection and Assessment
- ☐ Infrastructure Mapping

LAND USE
- ☐ Disaster Evaluation
- ☐ Infrastructure Mapping
- ☐ Monitoring Change Detection
- ☐ Inventory

ENVIRONMENT
- ☐ Wetlands Management
- ☐ Surface Mining Evaluation
- ☐ Wildlife Habitat Mapping
- ☐ Pollution Site Identification and Monitoring

UTILITY NETWORKS
- ☐ Infrastructure Mapping
- ☐ Corridor Monitoring
- ☐ Area Economic Analysis
- ☐ Environmental Compliance

☐ **Other** _____

Additional Information:

☐ NGTCA ☐ DA/PP ☐ OP ☐ NSD ☐ VAGTCA ☐ IKIN ☐ SPECI ☐ SD

COS